An Energy Efficiency Workshop & Exposition

Kansas City, Missouri

Keeping it Going

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Outline of Today's Presentation

- Concepts of persistence and continuous commissioning
- Preventative and predictive maintenance
- Hardware and software tools
- Diagnostic Examples
- Applications at Pantex and the Ann Arbor EPA Lab

Persistence

- The degradation of energy savings over time resulting from loss in measure efficiency or effectiveness, or from disabling the measure or reverting to the original technology.

Medical Analogy for Buildings

- Use diagnostics to identify problems
- Develop plan to fix problems
- Implement corrective procedures
- Continue to monitor systems for reoccurrence of problems

Continuous Commissioning

- A process for maintaining persistence
- Don't just commission a building once and then you are done
- Make it a cornerstone of an overall O&M program

O&M Basics

- Hand logs
  - May seem outdated, but hand logs can be very useful.
  - No substitute for experienced eyes and ears
- Preventative Maintenance
  - Regular maintenance at preset intervals
  - Many canned and customized software packages available

Predictive Maintenance

- Alternative to some preventative maintenance procedures
- Used to determine when a component is about to fail instead of just changing it because “it’s time”
- Examples: vibration analysis, oil analysis, infrared thermography, ultrasonic noise detection.

Diagnostic Tools - Hardware

- Hand held devices for spot measurements
- Portable data loggers
- Permanent data loggers

Hand Held Tools

- Power meter
- Temperature gages
- Manometers
- Flowhoods

- Hand Held Wattmeter
  - amps
  - volts
  - true RMS power
  - power factor
  - crest factor
  - wave form

Portable Data Loggers

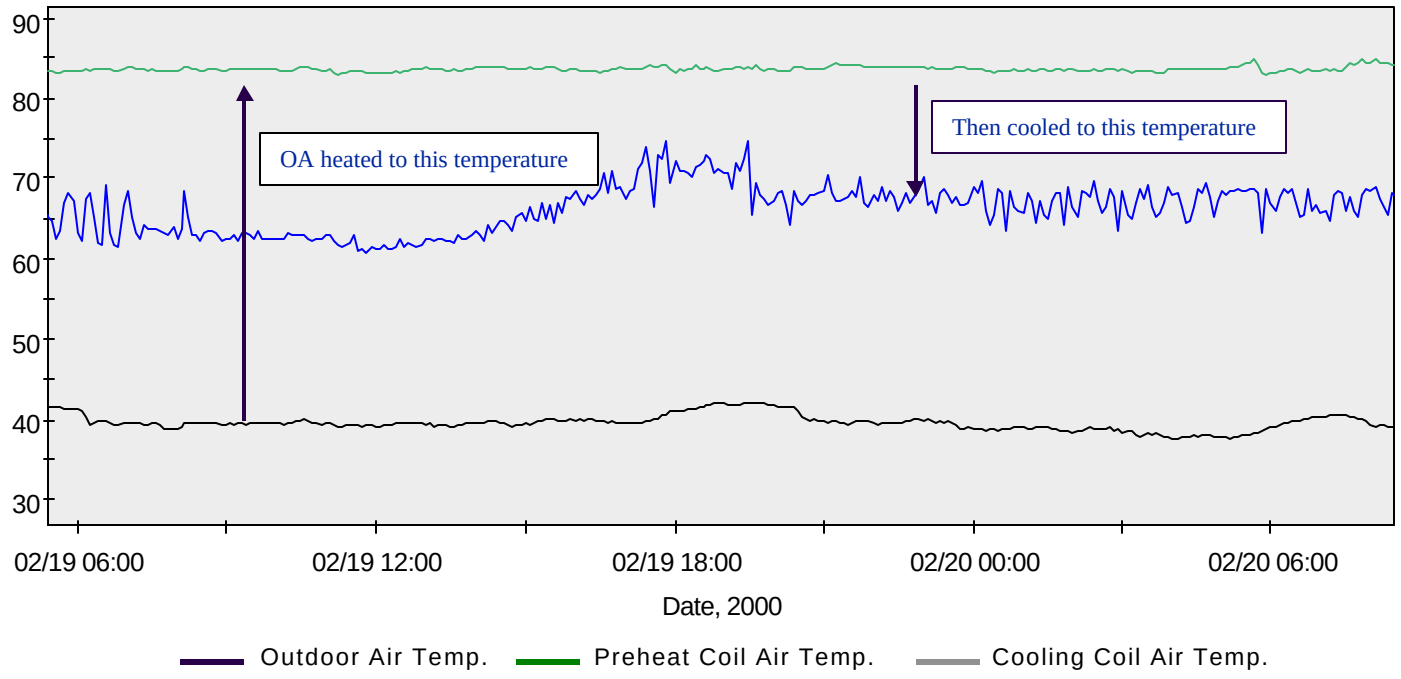
- Gather information on setpoints, schedules, loadshapes, etc
- Short term diagnostic testing
  - Observe dynamic performance changes as opposed to static conditions.
  - Observe system operation in their “natural” operating modes.
  - Software provides semi-automated diagnostics, data visualization, advanced filtering.

Portable, Battery-Powered Data Logger

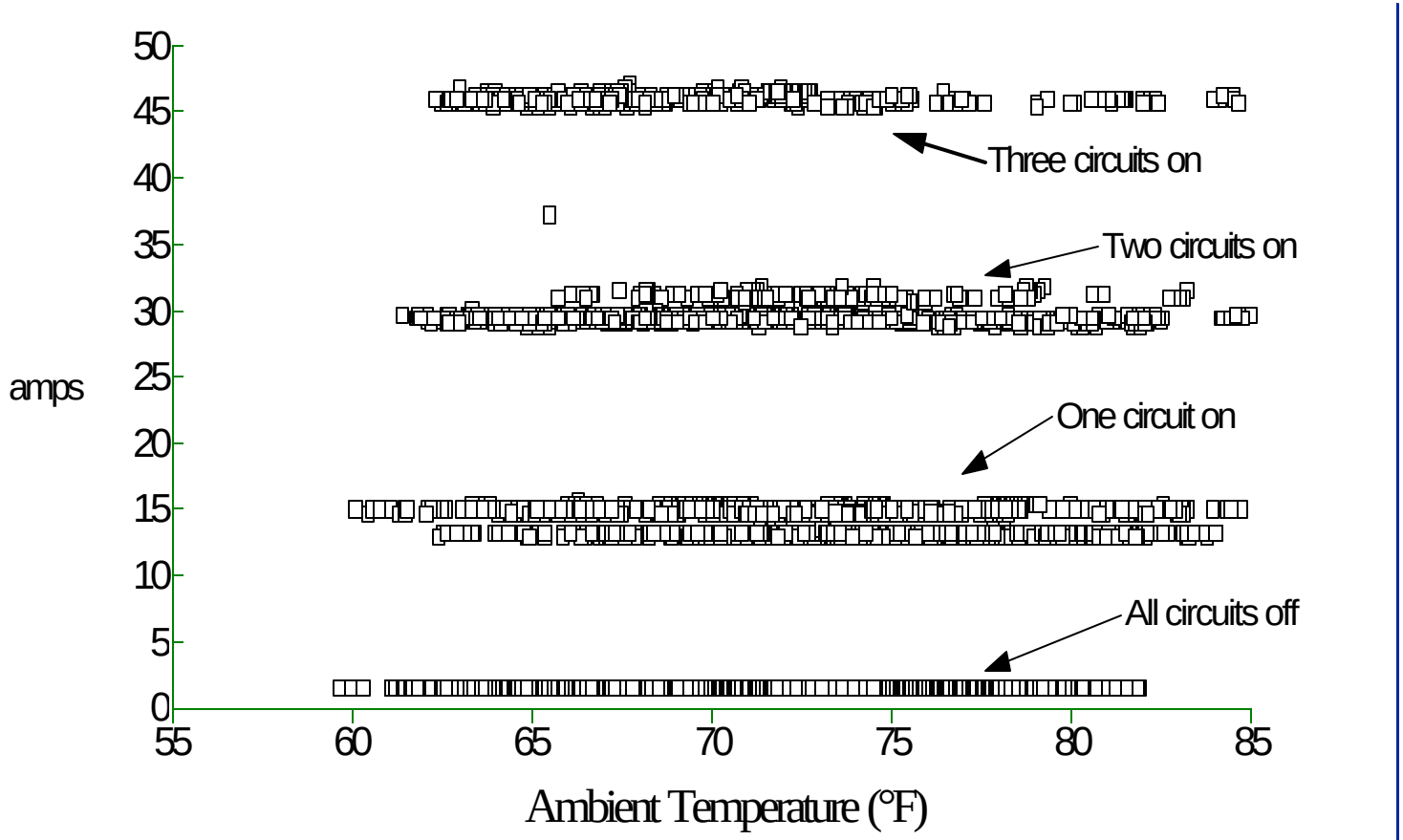
- Installation of data logger in a motor control center

Example Diagnostic Plot #1

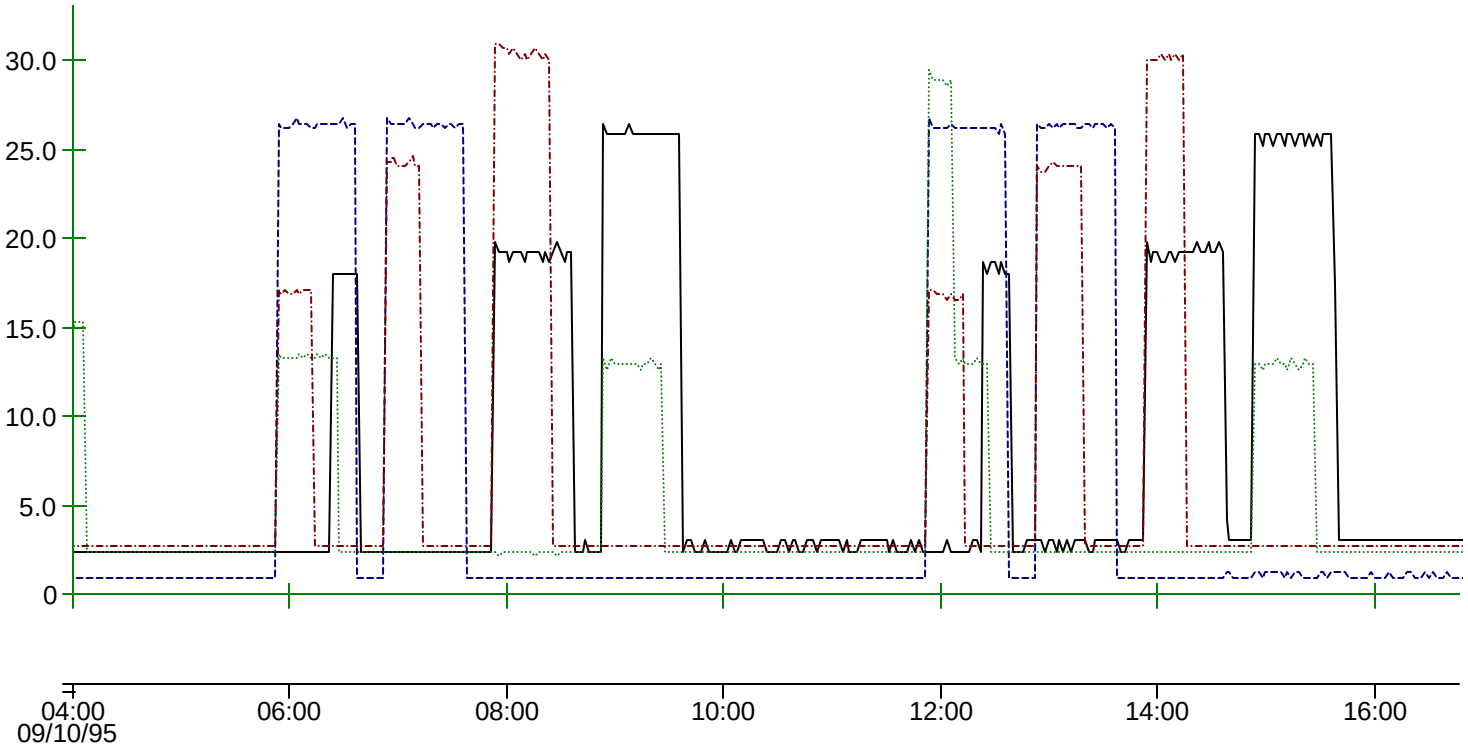
Simultaneous Heating and Cooling



Example Diagnostic Plot #2 - Duct Heaters



Example Diagnostic Plot #3 Electric Defrost Circuits



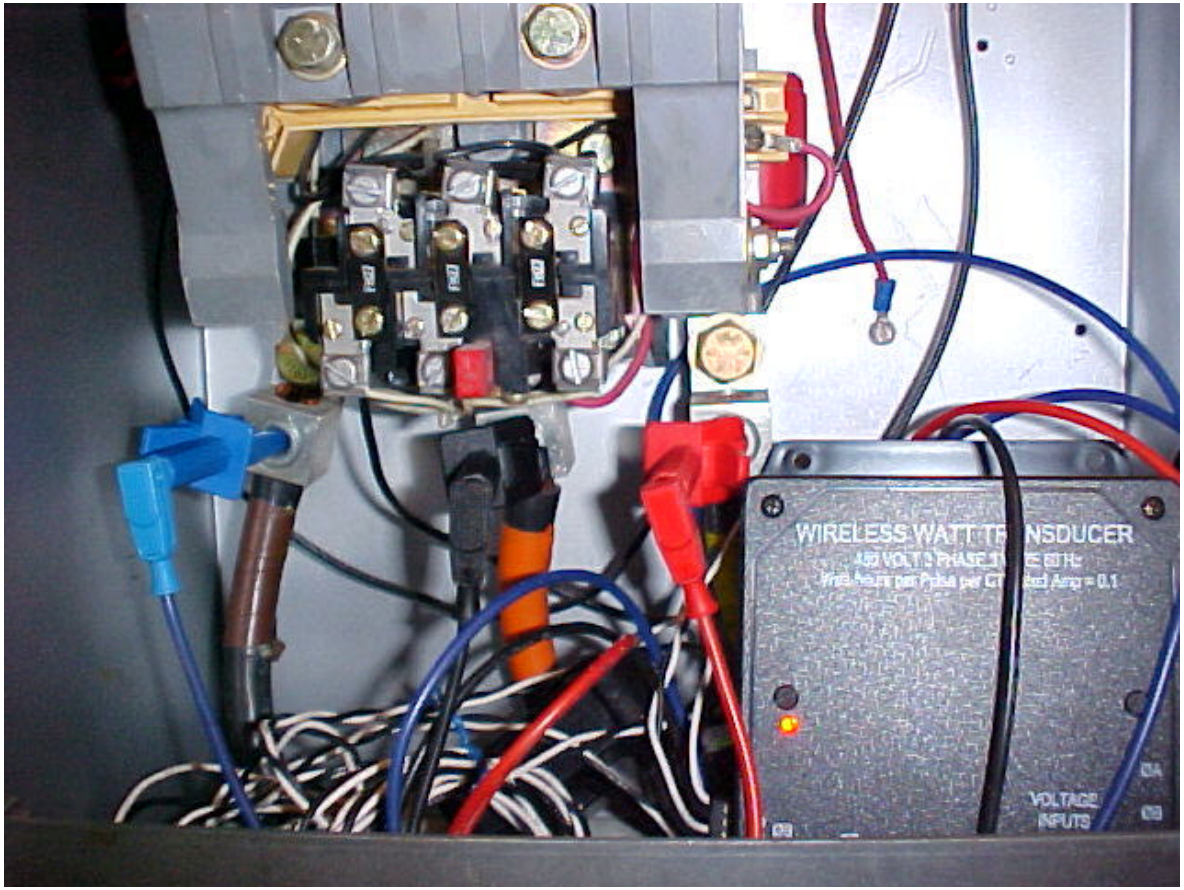
Permanent data loggers

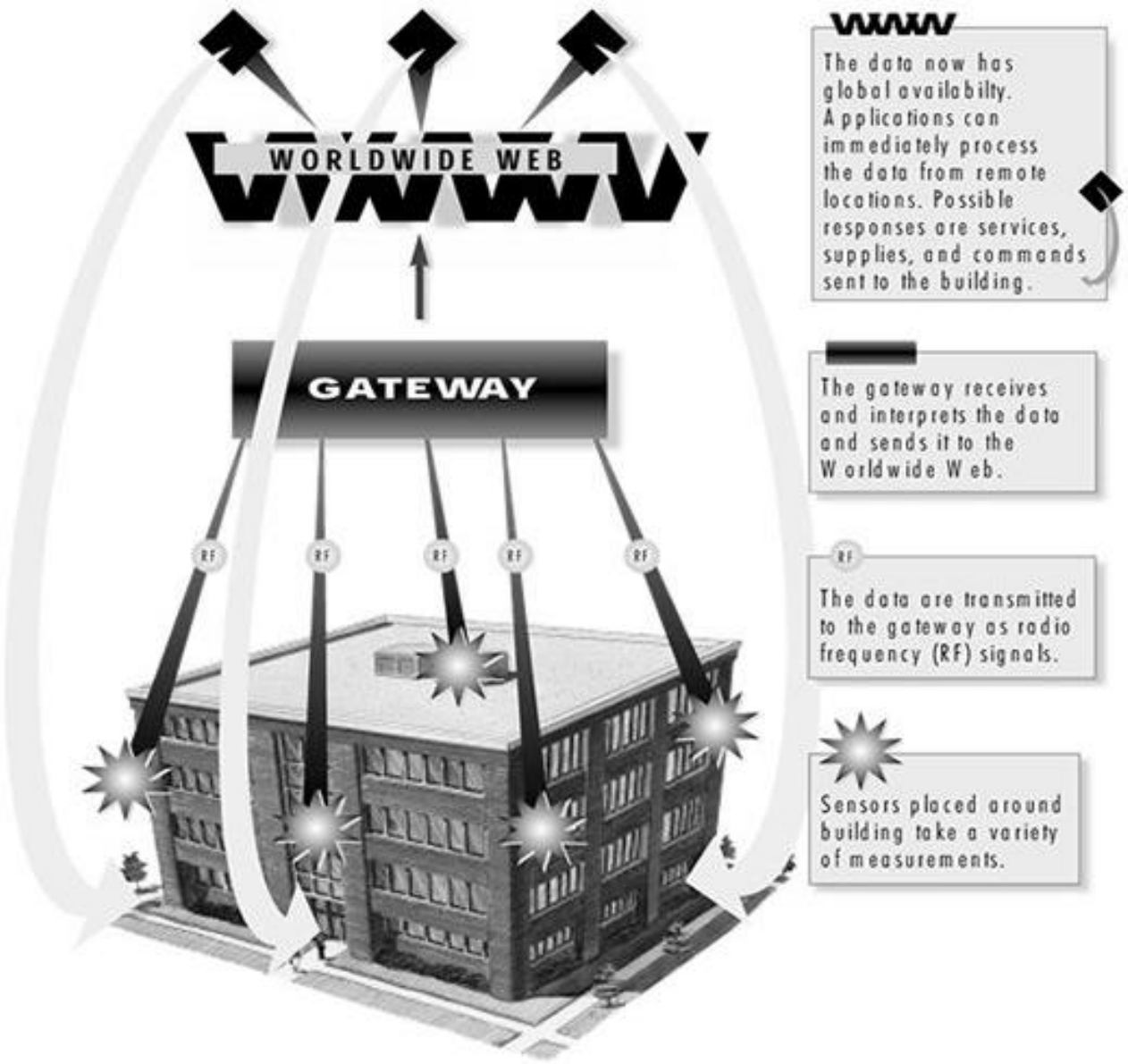
- Used to verify long term performance
- EMCS now capable of this task
- Lots of data to analyze

New Wireless Monitoring Technology

- Wireless system is Internet accessible
- Sensors transmit to receiver located in a nearby PC
- Capable of limited control, not just monitoring
  - demand limiting
  - others

Wireless Watt Transducer




WORLDWIDE WEB
WWW
GATEWAY
RF
RF
RF
RF
RF
WWW
The data now has global availabilty. Applications can immediately process the data from remote locations. Possible responses are services, supplies, and commands sent to the building.
The gateway receives and interprets the data and sends it to the Worldwide Web.
RF
The data are transmitted to the gateway as radio frequency (RF) signals.
Sensors placed around building take a variety of measurements.

Diagnostic Tools - Software

- Computer simulation
- Data analysis / diagnostics programs
- Spreadsheets

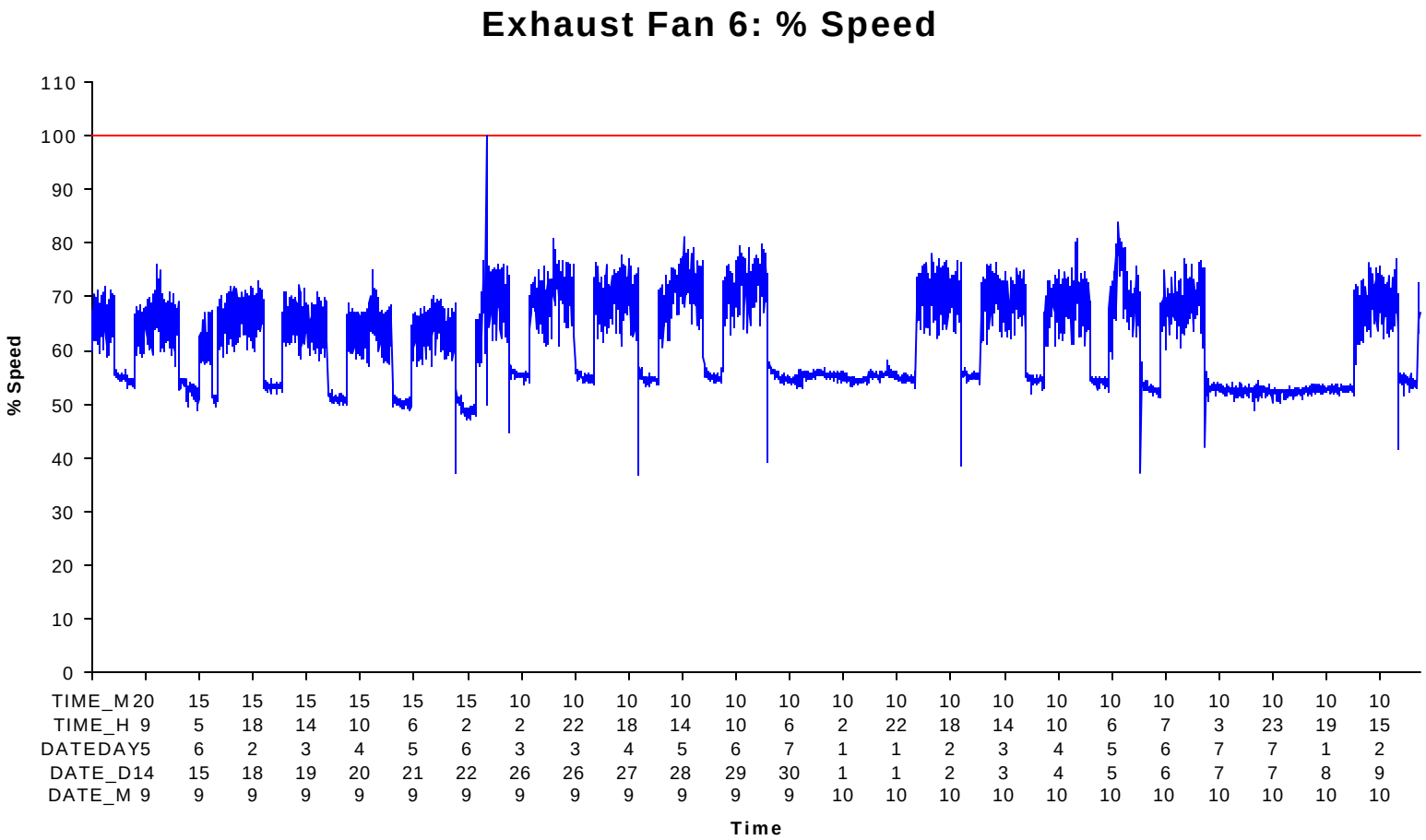
Data analysis / diagnostics programs

- ENFORMA
- PACRAT
- Universal Translator
- Whole Building Diagnostician

Using the EMCS for diagnostics

- Now have more capability for data collection and analysis (speed & memory)
- On-line diagnostics
  - making sense out of trend logs
- Submetering Applications
  - billing
  - diagnostics

EMCS Trend Logs



Problem at Pantex

- No funding for the Low Cost portion of the Low Cost / No Cost Program
- No funding for the $1,000,000 effort for Construction Support agreed to in the ESPC contract
- No funding for the contractually obligated manufacturer recommended maintenance on ESPC installed equipment
- Guaranteed Savings portion of contract negated if this isn't performed!

Solution for Pantex

- Establish a site-wide Continuous Commissioning Program on HVAC systems
- Generate enough savings to pay for the ongoing commissioning program
- AND enough savings to pay for the ESPC construction and maintenance effort

Commissioning Program Goals

- Engage commissioning firm to develop a Continuous Commissioning Plan for Pantex
- Train energy manager in procedures of commissioning and the use of hardware and software for operational diagnostics
- Establish templates to document the planning, investigation, implementation, and results of commissioning effort

Commissioning Program Goals

- Achieve energy savings through low cost no cost improvements to existing mechanical systems
- Provide documentation of savings to assist the Pantex energy manager in planning expenditures within the utility procurement budget
- Provide sufficient documented energy savings to fund the required operations and maintenance requirements associated with the ESPC
- Satisfy the operational needs of the occupants of each selected facility

Commissioning Program Methodology

- Short-term Diagnostic Monitoring
- Use hardware and software tools specifically oriented towards operational diagnostics
- Dedicated software manages, calculates and filters the data, then provides diagnostic plots to analyze system performance
- Investigates dynamic interactions between components and systems
- Provides information for diagnostics and M&V baseline

Pantex - Conclusions

- Diagnostic tools (hardware and software) are effective and efficient commissioning tools
- Consistent methodology for data collection and analysis
- Simultaneously provide diagnostics and energy information
- Initial results show potential energy savings
- Program meets objectives in very challenging work environment (financial, security, labor)

Keeping it Going in Ann Arbor

- Project Goals
  - Save Energy
  - Comply with Energy Policy Act
  - Comply with Exec. Order 12902
  - Restore aging, energy inefficient building infrastructure

EPA's NVFEL in Ann Arbor

What Did We Get?

- EPA's First ESPC
- 37 Roof Top Air Handlers
- Two Natural Gas Chiller / Heaters
- 200 kW Natural Gas Fuel Cell
- $10.6M Upgrade Without Up Front Funding

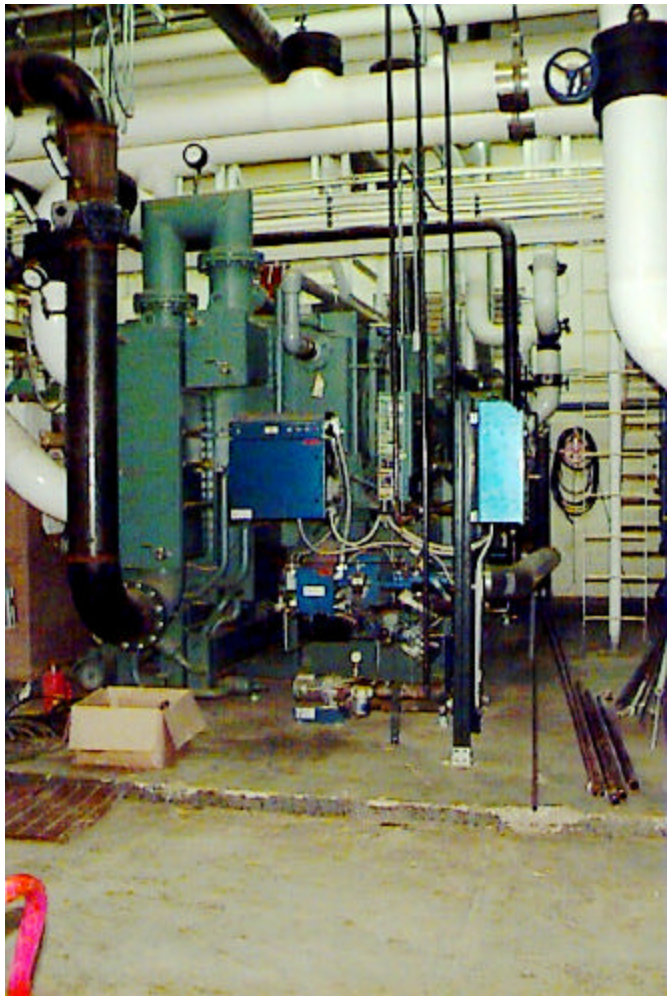
What Do We Expect?

- 50% Less Energy Consumption
- Lower Utility Plant Emissions
- Lower Site Emissions
- To Serve as an Example to Other Public and Private Sector Facilities

Installed ECMs

- New Air Handlers
- New central plant
- New EMCS

Chiller / Heater



New Air Handling Units

200 kW Fuel Cell

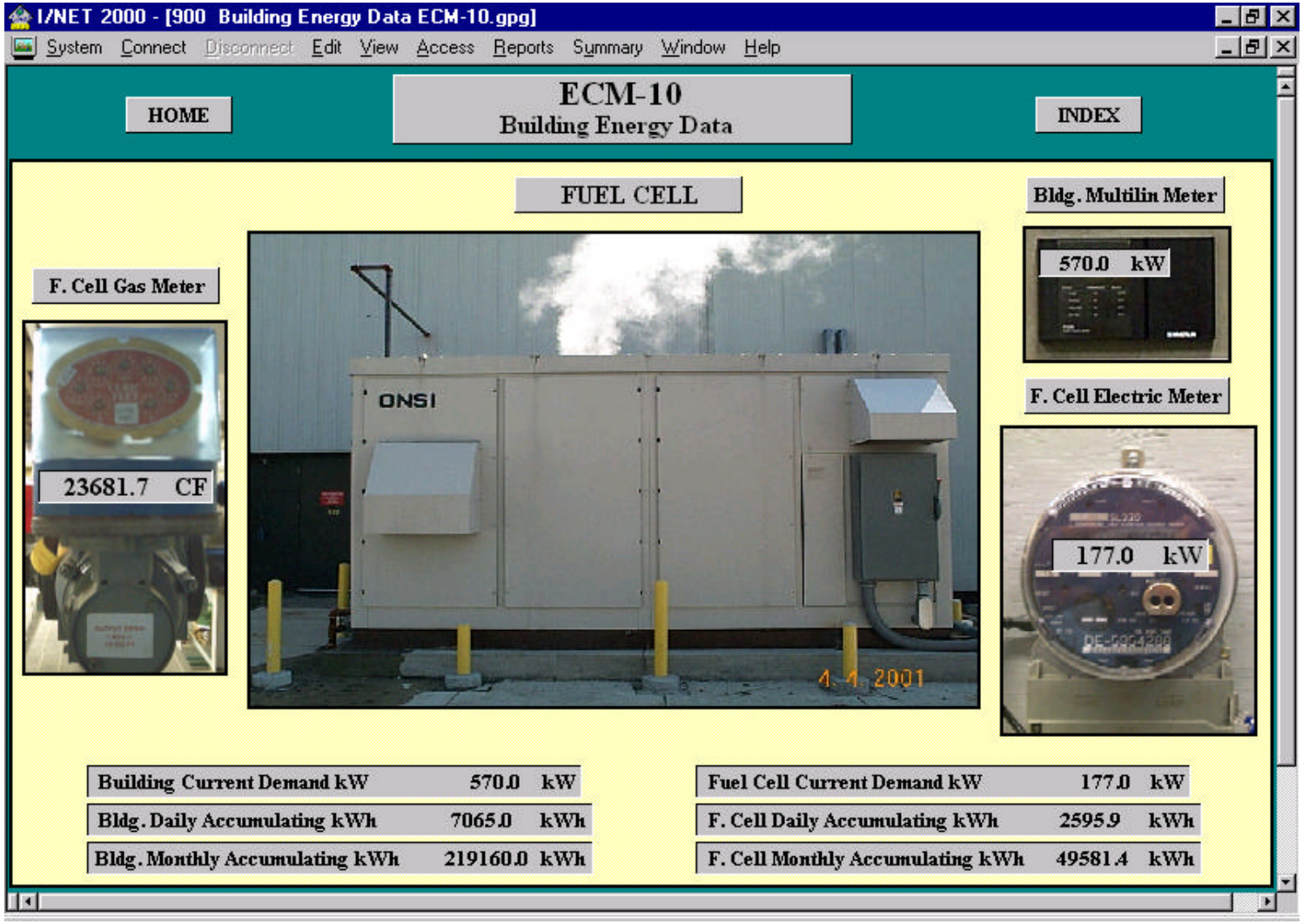
Tools Used at Ann Arbor

- Baselining and ECM Identification
  - Short tem diagnostic testing
  - Calibrated building energy model
- Post Retrofit Tools
  - Detailed M&V using the EMCS
  - System Diagnostics using the EMCS

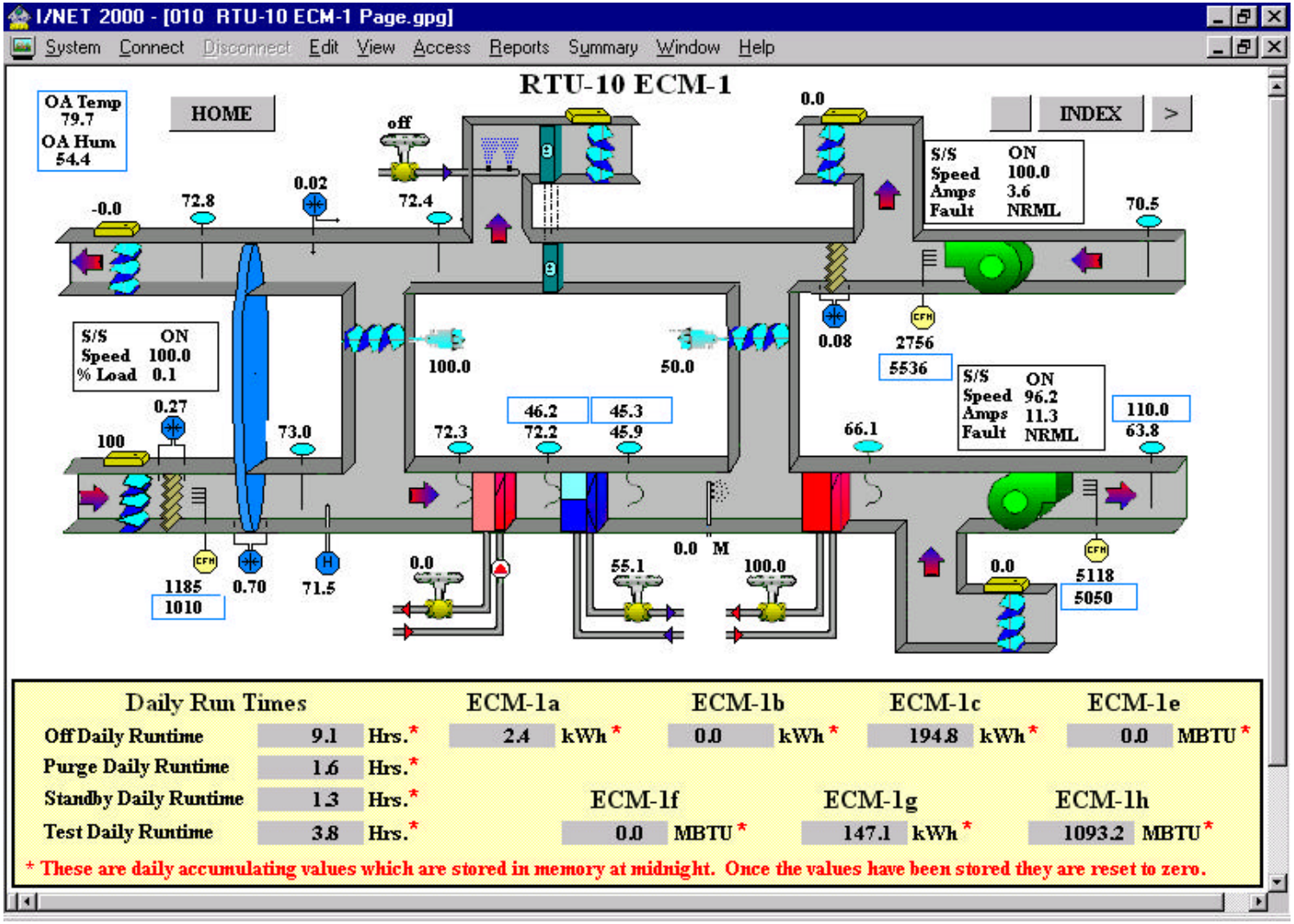
Justification for Obtaining Tools

- Needed for ESPC
- Detailed M&V plan required some sophisticated tools
- Costs are rolled into ESPC payments

Fuel Cell Energy Accounting



M&V Accounting by AHU



System Diagnostic Summary

- Original concept was whole building COP
- Modified concept to system and component level diagnostics
- Focus on Test Cell AHUs and central plant
- Set alarm flags for non-optimal performance

System diagnostics equations

Key persistence issue - control of test cells

- Honor system with enforcement
- Has been a culture change
- Proposed parking ticket approach
- Avoid using computer for AHU shutdown

THANK YOU

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